

ENGINEERING: THE DESIGN AND IMPLEMENTATION OF A VERSITILE HIGH GAIN ELECTRON TUBE GUITAR AMPLIFIER BY UTILIZING MULTIPLE POWER AMPLIFIERS

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With the development of transistors and digital signal processing, not to mention the current development of digital amplifiers, there seems to be little use for the electron vacuum tube in today's amplifier industry. After all, the vacuum tube is associated with numerous difficulties, such as major heat problems, extensive power supplies, and very nonlinear amplifying characteristics. Despite these obstructions the vacuum tube is still the choice of amplification source in the guitar amplifier industry. Over 95% of all the vacuum tubes used in the world today are used in guitar amplifiers. Vacuum tubes generate even harmonics when amplifying a signal, which sound very pleasing to the human ear. Transistors, on the other hand, create odd harmonics, which, mathematically, don't make musical sense to the human mind; thus vacuum tubes are the preferred source for amplification.

The electron tube became insufficient with the development of the transistor in the 1960s, and was quickly removed from the consumer electronics market. As the electron tube disappeared from the market so did the art form of classic analog circuit design. There is extremely little documentation regarding circuits and biasing schemes for electron tubes, mostly due to the fact that only a select few know how to design them. Furthermore, the circuit models that have been developed are only partially accurate due to the nonlinear characteristics of the vacuum tube.

Over its 60-year lifespan, the guitar amplifier has evolved to take on various elaborate designs based on function, cost, and performance. Many designs became unnecessarily complex and were considered unreliable due to various design mistakes, mainly neglecting the excessive heat dissipation that tubes produce. Today's guitar amplifier manufacturers focus on bringing versatility to the guitar player. By utilizing digital signal processing, companies are simulating popular classic guitar amplifiers and packaging an array of "virtual amplifiers" in one unit. Although the DSP algorithms model the even harmonic of tubes characteristics accurately, the DSP processors don't enter saturation gradually like electron tubes, which limits the DSP technology to possess the same sonic characteristics as electron tubes.

My goal became to create a versatile amplifier that doesn't simulate multiple amplifiers, but it actually has different tube amps the user can select from depending on the tone they seek. In early 2003 I initiated a research project to develop a high gain electron guitar amplifier that combined the best characteristics from British and American amplifiers. To accomplish this I strayed from traditional guitar amplifier design techniques and constructed an aberrant design. Since the power amplifier has a major impact on the sound characteristics of the amplifier, I found it necessary to include two power amplifiers to capture both American and British tone styles. Another innovative feature of the amplifier is the unique choice of preamplifier signal processing. The signal is sent through a 7-band equalizer circuit prior to preamplification, and this enables the user to emphasize specific frequencies for even harmonic gain.

The presentation will include a brief explanation of the history of the vacuum tube, electron tube amplification, biasing schemes, and power networks required for operation. Other topics covered will be design techniques, heat transfer problems, amplifier theory, and a description of the design process.